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SOLAR OBSERVATIONS

SOLAR OBSERVATIONS DURING JUNE 1937

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal for June at Washington and Lincoln, and close to normal at Madison.

Through the courtesy of Mr. Marion Eppley of the Eppley Laboratory, Newport, R. I., summaries of total solar and sky radiation received on a horizontal surface at Newport will be included in table 2 beginning with this issue. The instrumental equipment consists of an Eppley thermoelectric pyrheliometer recording on a Leeds and Northrup mixromax potentiometer. The coordinates of the station are as follows: Latitude, 41°30′ N., longitude 71°19′ W., and elevation of the pyrheliometer above sea level, 52 feet.

Table 2 shows an excess in the amount of total solar and sky radiation received on a horizontal surface at Madison, Lincoln, Chicago, New York, and Fresno, and a deficiency at all other stations.

Owing to an intensive program of calibration of a number of pyrheliometers during the month, no turbidity measurements were made.

Polarization observations made at Washington on 5 days give a mean of 57 percent with a maximum of 60 percent on the 24th. At Madison, observations made on 6 days give a mean of 52 percent with a maximum of 62 percent on the 30th. The values for Washington are close to normal, but those for Madison are considerably below the normal for June.

TABLE 1.—*Solar radiation intensities during June 1937*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.				[1]1.0	P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 7	15.65	------	0.48	0.66	0.82	1.16	------	------	------	------	16.79
June 12	12.24	0.71	.78	.87	1.18	------	------	------	------	------	7.87
June 22	13.13	------	------	1.10	1.24	1.48	------	------	------	------	10.59
June 23	9.14	------	1.03	1.16	1.27	1.49	------	------	------	------	8.48
June 24	12.22	------	.58	1.00	1.26	1.45	------	------	------	------	9.83
Means	------	(.71)	.72	.96	1.15	1.40	------	------	------	------	------
Departures	------	+.16	+.04	+.17	+.20	+.15	------	------	------	------	------

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during June 1937*—Contd

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.				1.0	P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 10	6.27	------	------	------	------	1.50	1.27	------	0.88	------	6.27
June 11	7.04	------	------	------	1.22	1.32	------	------	------	------	6.50
June 18	11.38	------	.60	.83	1.08	1.20	------	------	------	------	11.81
June 22	11.38	------	------	------	1.20	1.49	------	------	------	------	11.81
June 24	19.89	------	------	.84	1.03	1.32	------	------	------	------	21.28
June 25	24.31	------	.56	.71	.80	------	------	------	------	------	23.52
June 30	8.48	------	1.06	1.12	1.24	1.50	------	------	------	------	7.57
Means	------	------	.74	.88	1.10	1.39	(1.27)	------	(.88)	------	------
Departures	------	------	−.11	+.09	+.06	+.06	------	------	------	------	------

LINCOLN, NEBR.

June 14	10.59	------	------	------	------	------	1.11	0.87	0.74	0.58	11.38
June 21	17.96	------	0.87	1.02	1.09	1.41	1.12	.96	.86	.73	12.24
June 22	13.13	.75	.82	.93	1.18	1.39	1.03	.80	.63	.48	13.61
June 23	15.65	.73	.88	1.01	1.21	1.40	1.11	.91	.76	.63	10.97
June 24	14.60	------	.23	.32	.56	------	------	------	------	------	14.60
June 30	9.14	------	------	------	------	------	1.17	1.03	.90	.80	8.81
Means	------	(.74)	.70	.82	1.01	1.40	1.11	.91	.78	.64	------
Departures	------	−.02	−.08	−.11	−.11	+.04	.00	−.01	−.01	−.03	------

BLUE HILL, MASS.

June 4	11.1	------	------	------	------	1.20	------	------	------	------	9.8
June 6	11.1	------	------	------	------	1.32	0.94	------	------	------	11.6
June 7	16.4	------	------	------	------	1.07	------	------	------	------	16.6
June 9	11.9	------	------	------	0.98	1.20	------	------	------	------	11.8
June 12	10.3	------	------	0.83	1.08	1.34	1.24	------	------	------	8.8
June 13	9.2	------	------	------	1.05	1.18	1.03	1.09	------	------	7.7
June 15	12.8	------	------	------	.81	1.15	------	------	------	------	14.1
June 16	9.9	------	------	------	1.10	1.23	------	------	------	------	8.0
June 17	10.7	------	------	------	------	1.27	1.01	------	------	------	12.8
June 20	10.7	------	------	------	------	1.30	------	------	------	------	12.1
June 23	9.9	------	------	------	------	1.36	1.06	------	------	------	7.8
June 24	8.8	------	------	.94	1.16	1.43	1.19	1.03	0.89	------	8.5
June 25	10.3	------	------	------	------	1.37	------	------	------	------	9.5
June 29	11.9	------	------	------	------	1.05	1.07	------	------	------	11.6
Means	------	------	------	(0.88)	1.03	1.25	1.08	(1.06)	(.89)	------	------
Departures	------	------	------	−.12	−.04	−.03	.00	+.03	−.01	------	------

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	Gram-calories per square centimeter																
1937	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
June 4	593	544	534	429	489	746	483	638	571	386	399	540	562	652	636	440	494
June 11	447	515	516	417	524	708	432	514	621	460	392	593	563	585	388	447	542
June 18	505	638	695	520	436	753	554	589	613	353	387	621	416	552	407	677	418
June 25	414	646	599	537	408	680	383	631	509	392	413	604	377	595	569	422	428
	Departures from weekly normals																
June 4	+93	+33	−16	−14	+57	+87	+1	+64	.....	−122	−81	−15	+48	.....	+17	−38	.....
June 11	−50	+8	−29	−32	+82	+ 6	−62	−112	.....	−20	−93	−15	+43	.....	−155	−63	.....
June 18	+12	+111	+112	+52	+ 2	+28	+34	−99	.....	−93	−73	−1	−92	.....	+75	+155	.....
June 25	−112	+110	−4	+93.	−39	−41	−67	−23	.....	−108	−37	+4	−171	.....	+2	−103	.....
	Accumulated departures on July 1																
	−868	+1,204	−1,218	+702	+3,633	+3,500	+1,561	+154	.....	−5,579	+5,306	−2,394	−889	.....	−910	−1,995	.....

TABLE 3.—*Total, I_m, and screened, I_v, I_r, solar radiation intensity measurements, obtained during June 1937 and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air mass	I_m	I_v	I_r	(*) $\frac{I_v}{.851+C}$	(*) $\frac{I_r}{.840+C}$	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Mass in lower layers	Mass aloft
									Percentage of solar constant			Air-mass type	
1937	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*			*mm.*		
June 4:													
0:32 a	68 47	1.07	1.148	0.890	0.583	1.072	0.714	0.100	77.0	16.1	14.6	NPC/S.	
June 7:													
1:28 p	63 13	1.12	0.992	.643	.502	.782	.615	.152	70.3	17.8	17.0	NP/TA.	
2:39 p	51 14	1.52	.907	.591	.490	.710	.601	.140	65.4	17.3	16.3		
June 9:													
5:05 a	25 18	2.33	.919	.615	.498	.744	.610	.092	70.5	21.7	14.4		
1:45 a	61 04	1.15	1.154	.737	.583	.891	.713	.120	77.2	15.7	14.8	NP/S.	
0:04 a	70 39	1.06	1.183	.724	.591	.876	.724	.092	79.0	16.2	15.0		
June 12:													
3:49 a	34 41	1.56	1.150	.743	.593	.899	.728	.066	81.3	20.4	16.5		
1:41 a	61 47	1.13	1.221	.794	.636	.961	.780	.073	83.3	18.5	17.6	NPC.	
2:49 p	50 34	1.29	1.221	.777	.616	.945	.755	.086	78.9	13.5	12.1		
June 13:													
4:37 a	30 46	1.95	1.070	.682	.557	.830	.684	.081	71.7	14.8	10.7		
3:01 a	48 10	1.34	1.263	.780	.626	.945	.768	.075	76.6	8.4	7.3	NP.	
0:24 a	70 20	1.06	1.341	.820	.660	.997	.810	.094	76.3	5.0	4.9		
3:54 p	37 58	1.62	1.135	.702	.585	.850	.716	.116	67.6	6.9	4.3		
June 15:													
3:52 a	38 46	1.59	.963	.608	.483	.745	.593	.124	64.7	13.5	10.8	NP.	
0:29 p	70 08	1.06	1.126	.658	.553	.827	.679	.100	77.6	17.7	17.4		
June 16:													
3:53 a	38 41	1.60	1.164	.750	.599	.910	.735	.100	68.3	6.3	5.0		
1:52 a	59 36	1.16	1.210	.791	.636	.957	.780	.112	74.3	9.9	8.4	NPC/S.	
1:07 p	66 32	1.09	1.144	.754	.603	.913	.745	.153	71.0	10.1	9.8		
June 17:													
0:44 a	69 04	1.07	1.247	.798	.644	.967	.797	.134	73.2	6.9	6.7	NP/NPM.	
1:10 p	66 11	1.09	1.251	.802	.626	.978	.774	.084	78.9	12.3	10.9		
June 23:													
4:17 p	34 30	1.76	1.195	.770	.607	.935	.751	.055	75.7	11.9	9.1	NPC/NPA.	
June 24:													
4:26 a	32 32	1.86	1.160	.747	.602	.930	.740	.050	74.1	12.5	9.3		
2:58 a	48 40	1.60	1.248	.794	.620	.962	.762	.029	80.5	14.0	11.2		
0:24 p	70 20	1.06	1.414	.867	.688	1.052	.845	.050	83.8	8.5	8.3	NPC/NPP.	
2:22 p	54 00	1.24	1.349	.842	.652	1.021	.801	.026	84.7	12.8	11.6		
4:23 p	32 51	1.84	1.200	.776	.600	.942	.737	.033	78.8	14.9	11.1		
June 25:													
0:37 a	69 40	1.06	1.365	.838	.648	1.014	.797	.028	87.1	14.4	14.1	NPC/NPP.	
June 29:													
3:55 p	36 05	1.69	.972	.656	.504	.796	.631	.102	67.9	16.1	12.5	NPA/S.	

* Corrected for transmission of screens and reduced to mean solar distance.

Meteorological Conditions During Solar Observations, Blue Hill Meteorological Observatory, June 1937

Date	Time from local noon	Temperature °C	Wind Beaufort	Visibility	Sky blue	Haze[1]	Cloudiness and remarks
June 4	0:32 a. m.	20.0	WSW 3	7	8	1	6 Cu.
7	0:19 a. m.	22.8	ENE 3	6	7	2	8 Cu.
7	1:28 p. m.	23.1	NE 2	6	7	2	3 Cu.
7	2:43 p. m.	24.4	NE 2	6	7	2	1 Ac, 1 Cunb.
9	5:05 a. m.	16.7	SW 4	8	8	0	Zero clouds.
9[2]	2:07 a. m.	22.8	SW 3	7	8	1	Zero clouds.
9	1:45 a. m.	22.8	SW 3	7	8	1	Zero clouds.
9[2]	0:26 a. m.	25.0	SSW 3	7	8	1	Few Cu.
9	0:04 a. m.	25.6	SSW 3	7	8	1	Few Ci., 1 Cu.
12	3:49 a. m.	18.9	NW 2	7	8	0	Few Cu.
12	1:41 a. m.	22.5	SW 2	8	8	0	Few Ci., Few Cu.
12	2:49 p. m.	24.4	SW 3	8	8	0	4 Cu.
13	4:37 a. m.	17.8	W 4	8	8	0	Few Ci.
13[2]	3:13 a. m.	21.0	W 3	8	8	0	Few Ci.
13	3:01 a. m.	21.0	W 3	8	8	0	Few Ci.
13	0:24 a. m.	23.2	W 5	8	8	0	Few Ci., Few Cu.
13	3:54 p. m.	25.7	WSW 3	9	8	------	Few Cu.
15	3:52 a. m.	20.3	NW 3	8	8	0	Few Cu.
15	0:29 p.m.	23.1	NNE 2	8	8	1	4 Cu.
16	3:53 a. m.	18.4	ENE 3	9	8	1	Few Ci.
16	1:52 a. m.	20.3	E 3	9	8	0	Few Ci.
16[2]	1:45 a. m.	20.4	E 3	9	8	0	Few Ci.
16	1:07 p. m.	23.2	E 2	9	8	0	2 Ci.
17	0:44 a. m.	21.7	E 2	8	8	1	2 Ci.
17	1:10 p. m.	22.8	SE 2	8	8	1	1 Ci., Few Cu.
23	4:14 p. m.	21.2	SE 1	9	8	0	8 Ci., Few Ac., Few Cu.
24	4:26 a. m.	18.9	NNE 2	6	7	2	Few Ci.
24[2]	3:21 a. m.	21.0	N 2	6	7	2	Few Ci.
24	2:58 a. m.	21.1	NE 3	6	7	2	Few Ci.
24	0:24 p. m.	21.9	NE 3	9	7	0	Few Ci., Few Cu.
24	2:28 p. m.	21.9	NE 3	9	7	0	Few Ci., Few Cu.
24	4:23 p. m.	21.7	NE 3	9	7	0	Few Ci., Few Cu.
29	3:55 p. m.	19.3	NE 3	4	8	0	2 Ci., Few Cu.

[1] Haze—0 Light; 1 Moderate; 2 Dense.
[2] Indicates Smithsonian Observation.

AREAS OF SUNSPOTS MEASURED AT MOUNT WILSON OBSERVATORY

By SETH B. NICHOLSON

[Mount Wilson Observatory, Carnegie Institution of Washington, July 1937]

The areas and positions of sun spots have been published monthly since January 1927 by the U. S. Naval Observatory in the MONTHLY WEATHER REVIEW. The Mount Wilson Observatory of the Carnegie Institution of Washington has cooperated in this program by measuring on the sketches made at the 150-foot tower telescope[1] the areas and positions of sunspots on the days requested by the Naval Observatory. It was early recognized that a large systematic difference existed between the areas so determined and those measured by the Greenwich Observatory, and in 1927 it was found that the areas given in the MONTHLY WEATHER REVIEW had to be increased by 41 percent to eliminate the systematic differences between them and the Greenwich measures.[2] The areas obtained at the Mount Wilson Observatory were apparently in close agreement with those from the Naval Observatory, although very different methods and equipment were used at the two observatories.

The publication of a note in the MONTHLY WEATHER REVIEW for February 1937 to the effect that the areas obtained at the Naval Observatory prior to 1937 should be multiplied by a factor of 1.5708 lead to an investigation of the large systematic differences between the areas determined from visual observations and those obtained from photographs.

Our drawings of sunspots have been made by several different observers, and with one exception all have drawn the spots consistently smaller than shown on photographs; no significant systematic errors were made in their measurement. Areas measured from photographs taken at Mount Wilson agree very closely with those measured at Greenwich, and photographs made with both yellow and blue light give essentially the same areas.

[1] MONTHLY WEATHER REVIEW, *55*, 85, 1927.
[2] Publications of the Astronomical Society of the Pacific, *41*, 277, 1929.

TABLE 1

Year	G./Mt.W.	Weight	G./N.	Weight
1927	1.33	6	0.88	47
1928	1.28	10	.86	71
1929	1.37	9	.88	61
1930	1.47	4	.91	16
1931	1.20	3	1.02	13
1932	1.09	1	.77	8
1933	1.29	1	.87	4
1934	1.19	1	1.18	5
Mean	1.31	----------	.89	----------

The mean factors by which the areas measured on the Mount Wilson drawings have to be multiplied to reduce them to the areas measured on photographs at Greenwich are given for each year in the second column of table 1. The factor to reduce the corrected Naval Observatory measures to the Greenwich scale are in the fourth column. The factor necessary to reduce the Mount Wilson areas to those of the Naval Observatory could not be determined directly, since measurements were made at Mount Wilson only on days for which photographs were lacking at the Naval Observatory. A comparison of both Naval and Mount Wilson Observatories with the Greenwich Observatory indicates that the Mount Wilson areas as published should be multiplied by 0.94 to reduce them to the published areas from the Naval Observatory prior to January 1937 and by 1.48 to reduce them to the corrected areas from the Naval Observatory. The weights in table 1 are proportional to the total areas.

The reason for such a large systematic difference between drawings and photographs probably lies in the fact that the contrast between photosphere and penumbra is reduced on the sketches and increased on the photographs.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h. m.	°	°	°				
June 1	11 46	−42.0	349.2	+12.0	-------	776	---------	U. S. Naval.
		+2.0	33.2	−17.0	-------	6	---------	
		+23.0	54.2	+17.0	-------	388	---------	
		+28.0	59.2	+11.0	-------	145	---------	
		+73.0	104.2	+11.0	-------	582	---------	
		+75.0	106.2	+12.0	-------	145	---------	
		+86.0	117.2	−20.0	388	---------	2,430	
June 2	10 57	−82.0	296.4	+10.5	-------	242	---------	Do.
		−69.0	309.4	+9.0	-------	24	---------	
		−29.0	349.4	+12.5	-------	921	---------	
		+12.5	30.9	−18.0	-------	48	---------	
		+36.0	54.4	+17.5	-------	242	---------	
		+41.0	59.4	+13.0	-------	242	1,719	
June 3	14 43	−83.0	280.1	−17.0	194	---------	---------	Do.
		−78.0	285.1	+10.5	-------	242	---------	
		−69.0	294.1	+10.5	-------	339	---------	
		−32.0	331.1	+10.0	-------	24	---------	
		−15.0	348.1	+13.0	-------	1,067	---------	
		+29.0	32.1	−17.0	-------	48	---------	
		+49.5	52.6	+17.5	-------	97	---------	
		+57.0	60.1	+14.5	-------	218	2,229	
June 4	11 5	−70.0	281.9	−16.0	194	---------	---------	Do.
		−64.0	287.9	+11.0	-------	242	---------	
		−56.0	295.9	+11.0	-------	388	---------	
		−40.0	311.9	+10.5	-------	73	---------	
		−11.0	340.9	+9.0	-------	12	---------	
		−2.0	349.9	+13.0	-------	1,067	---------	
		+11.0	2.9	−32.0	-------	24	---------	
		+16.0	7.9	+6.0	-------	12	---------	
		†+40.0	31.9	−17.0	-------	36	---------	
		+65.0	56.9	+17.0	-------	48	---------	
		+74.0	65.9	+14.5	194	---------	2,290	